Newton's First Law

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CONCEPT 1 Newton's First Law

The **First Law is about inertia; objects at rest stay at rest unless acted upon and objects in motion continue that motion in a straight line unless acted upon**. Prior to Newton and Galileo, the prevailing view on motion was still Aristotle's. According to his theory the natural state of things is at rest; force is required to keep something moving at a constant rate. This made sense to people throughout history because on earth, friction and air resistance slow moving objects. When there is no air resistance (or other sources of friction), a situation approximated in space, Newton's first law is much more evident.

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The amount of inertia an object has is simply related to the mass of the object. Mass and Weight are two different things. Mass (typically in units of kg or grams) is basically a measure of what comprises an object. Weight is the measure of how much the force of gravity is pulling on you. In fact, instead of saying 'I weigh 80 lb.', one could say that 'the force of gravity is pulling on me with a force of 80 lb.' The metric unit for weight (and force) is the Newton.

Key Equations

$$F_g = mg$$

;

The force of gravity (i.e. your weight) is equal to the mass of the object multiplied by the acceleration of gravity for that planet.

$$1\text{lb.} = 4.45\text{N}$$

Guidance

- An object will not change its state of motion (i.e., accelerate) unless a net force acts on it. Equal and oppositely directed forces do not produce acceleration.
- If no net force acts on an object the object remains at constant velocity or at rest.

Example 1

Question: What is the weight of a 90 kg person on Earth? What about the moon?

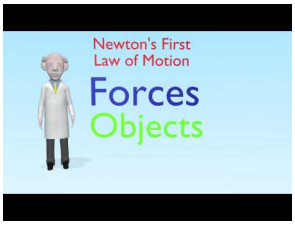
Answers: On Earth,

$$F_g = mg = (90\ kg)(9.8\ m/s^2) = 882\ N$$

On moon,

$$F_g = mg = (90\ kg)(1.6\ m/s^2) = 144\ N$$

Watch this Explanation



MEDIA

Click image to the left for more content.

Simulation

Try the following simulation to apply these principles.

- http://simulations.ck12.org/SledSim/

Time for Practice

1. When hit from behind in a car crash, a passenger can suffer a neck injury called whiplash. Explain in terms of inertia how this occurs, and how headrests can prevent the injury.
2. A cheetah can outrun a gazelle in a short straight race, but the gazelle can escape with its life by zigzagging. The cheetah is more massive than the gazelle – explain how this strategy works.
3. If your hammer develops a loose head, you can tighten it by banging it on the ground. A little physics secret though – it's better to bang the hammer *head up* rather than *head down*. Explain, using inertia.

4. If a man weighs 140 lb. on Earth, what is his weight in Newtons and his mass in kg?

Answers

1. The passenger's head will remain at rest for the split second when the seat exerts a big force on the passenger's back causing a "whiplash" on your neck. This is an example of newton's first law because your head is not acted on by an unbalanced force while the rest of your body is. A head rest causes your head to accelerate with the rest of your body.
2. The cheetah must exert a bigger force to change directions than the gazelle because the cheetah has more inertia. This extra force needed for the cheetah to change directions allows the gazelle to get away.
3. The head of the hammer has more inertia than the tail. So when you bang the hammer "head up" the head exerts a large force on the rest of the hammer in order to come to a stop.
4. 620 N, 62 kg (using 10 m/s/s for acceleration of gravity